Focus on Research

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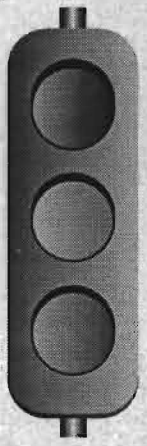
"Focus on Research updates engineers and technicians on items of interest upcoming in active TxDOT research projects."

TTI Reviewing Traffic Signal Controllers

Traffic signal systems developed by various signal control manufacturers differ in their programming details and in their system control features. The result is that most of these microcomputer-based, closed-loop systems are capable of communicating only with controllers produced by the same manufacturer. Such incompatibility creates problems in maintaining statewide equipment standards, cost-competitive procurement processes, and system operational practices. In addition, some hardware connection techniques cannot fully take advantage of many built-in advanced control features provided in some of the advanced traffic signal controllers. TxDOT needs basic sets of standard communications protocols and system control features established for different signal controllers, such that controllers from different vendors can be integrated into a traffic management system.



Project 0-1389, *Development of a Multi-Vendor Environment for Traffic Signal Controllers,* will determine to what extent different brands of traffic controllers can be effectively used in closed-loop signal systems in a manner acceptable to TxDOT engineers and maintenance personnel.

Study objectives include:

- Identifying current practices and determining the needs of traffic engineers and maintenance personnel;
- Developing and defining alternatives for providing closed-loop type traffic signal systems;
- Evaluating the feasibility and cost of implementing alternative system configurations for closed-loop traffic controller systems;
- Documenting findings and recommendations in a final report.

In view of the increasing emphasis on traffic operations and traffic management systems, the study findings will benefit TxDOT by reducing the substantial costs associated with installing and maintaining closed-loop-type traffic signal systems. This study will also provide the information necessary to assist department engineers in specifying those cost-effective control systems capable of minimizing delays, stops, and the environmental impacts of inefficient signal systems.

The study runs from September 1993 through August 1995.

Area 3 — Research Project Director (PD): Mel Partee, P.E., TRF
Researchers: Dr. Tom Urbanik, P.E., and Ed Seymour, TTI

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Texas Department of Transportation

Research and Technology Transfer Office, in cooperation with the FHWA

CTR Study Will Revise Partial Prestress Design

The construction of elevated roadways over existing Texas highways requires large structural members, examples of which include the large straddle bents and large cantilever bents being used in San Antonio. The great size of these members has led to design difficulties. Because of strength and serviceability requirements, and because current design specifications compartmentalize the design of "structural concrete" by separating prestressed concrete member design from reinforced concrete member design, large structural members are often designed to meet both the reinforced and prestressed concrete specifications. This practice can result in over-designed, extremely congested reinforcing cages. The application of what many researchers refer to as "partial prestressing," or a combination of prestressed and conventional reinforcement, could alleviate this design problem. By exploiting the attributes of reinforced and prestressed concrete design, engineers could conceivably produce more efficient and more durable structural members.

Project 0-1364, *Design of Large Structural Members Utilizing Partial Prestressing,* will evaluate the behavior of large cantilever bents having span/depth ratios (a/d) ranging from less than 1.0 to approximately 2.0. In addition, the project will assess the behavior of specimens constructed with different combinations of prestressed and nonprestressed reinforcement, and will develop a rational, unified structural concrete design methodology that includes applications of strut-and-tie models; such a methodology, as envisioned, will lead to more efficient use of combined prestressed and nonprestressed reinforcement.

A second objective is to make the findings available for consideration by code and specification-writing bodies as soon as results are approved by TxDOT.

The findings will eliminate ambiguities in current AASHTO bridge specification design procedures. Additionally, the project will lead to significant economic savings by reducing material quantities and costs associated with material placement. Finally, the use of these research findings in the design of large structural members should result in more durable structural members — which can, in turn, help reduce maintenance costs.

The Design Division will implement the study results by revising the design procedures for partially prestressed structural members. The project team will also submit the results to appropriate code and specification groups (e.g., AASHTO) for consideration and use nationally.

The project runs from September 1992 through August of 1995.

Area 4 — PD: Gustavo Morales-Valentin, P.E., DES Researchers: Drs. Michael Kreger, John Breen, and Ned Burns, CTR

New Guidelines for Designing Durable Posttensioned Substructure

The use of post-tensioned concrete for such relatively uncommon bridge substructure elements as straddle bents, hammerhead bents, and pylons is increasing rapidly. There is also a trend toward using post-tensioned concrete in large footings to reduce the size of the footing. Unfortunately, many bridge substructure elements are exposed to aggressive environments (e.g., saltwater, sulfate-rich soils, heavily polluted air, and deicing salts). No research has been conducted to document proper corrosion and sulfate-resistant designs of post-tensioned substructure systems, particularly duct, grout, and anchorage elements.

The objective of Project 0-1405, *Durability Design of Post-Tensioning Substructure Elements,* is to conduct a series of carefully designed experiments that will examine the durability of post-tensioned substructure elements subjected to a combination of aggressive environmental exposure and realistic structural loading. The study will also examine the potential for using post-tensioned concrete in caps, mats, and combined footings; appropriate anchor, tendon, and cover requirements will be categorized for further research.

The expected benefits will be enhanced design guidelines and construction specifications to mitigate the effects of aggressive exposure conditions on post-tensioned substructures. Tests will be conducted in the laboratory using accelerated aggressive exposure tests in which the structures are subjected to simulated structural loading.

The principal output of this project will be specific recommendations in language suitable for direct adoption in TxDOT standard specifications, TxDOT design criteria, and AASHTO specifications.

The project started in September of 1993 and will end in August of 1999.

Area 4 — PD: J. Bryan Hodges, P.E., DES Researchers: Drs. John Breen and Michael Kreger, CTR

Study Examines Stress Transfer in Bridge Structures

Over the past 20 years, the Texas Department of Transportation has supported a number of projects in the forefront of anchorage and development research. These efforts have led to recently proposed changes for anchorage and development in TxDOT design procedures for bridge structures and in ACI 318 for building structures. However, no TxDOT-sponsored research has addressed bar groups.

Currently designers use results from simple one- or two-bar tests to predict the behavior of bars in multiple layers in a pattern (e.g., a circular- or rectangular-shaped column framing in a footing or pier cap). The simple test results may not model the multiple layer behavior. Closely spaced bars (or bundled bars) in structural elements are necessary because of dimensional restraints and in order to meet strength requirements. Satisfying these requirements may necessitate the use of a large number of bars in the element's tension zone. If sufficient space is not available, the bars can be bundled to increase the clear distance between the bars for placing concrete or for distributing the bars in several layers. (It should be noted that even in some cases where congestion at a typical section may not be a problem, bars may have to be spliced; the section containing the splices will then have multiple bars, an arrangement that may reduce the clear spacing between bars and, thus, the anchorage capacity.) Whether incorporated at the base of columns anchored into footings, or constructed in several layers of multiple bars for the main reinforcement in beams or bent caps, bar groups represent an important area of study, especially since they are susceptible to group failure when subjected to high uniform stresses.

The project findings will improve our understanding of the mechanics of stress transfer in complex structural configurations.

For these reasons, there is a need to examine the performance of groups of bars (or bundled bars) subjected to tensile forces in the regions of anchorage and development.

Project 0-1363, *Anchorage and Development of Groups of Reinforcing Bars,* will establish typical TxDOT designs that use groups, bundles, and layers of bars. In addition, the project will investigate the development and anchorage of groups, layers, and bundles of bars to determine the applicability of current design equations and procedures for such reinforcement. Finally, the project will recommend procedures for implementing results into design (or modifications to those procedures) using AASHTO and TxDOT guidelines.

The project findings will improve our understanding of the mechanics of stress transfer (from steel to concrete) in complex structural configurations. The results — to be implemented through modification of existing TxDOT design procedures — can be used to provide consistent margins against structural failure, and to alleviate potential congestion problems associated with construction operations.

The project began in September of 1993 and will end in August of 1995.

Area 4 — PD: Dacio Marin III, P.E., DES
Researcher: Dr. J. O. Jirsa, CTR

Project Assesses HOV Efforts in Houston and Dallas

Tremendous growth has characterized Texas' urban areas since the early 1970s, prompting concerns about the state's mobility. In their search for new and innovative ways to move urban travelers more efficiently, state transportation planners have begun focusing on high-occupancy vehicle (HOV) projects. Because there are only about 40 HOV projects currently operating in the U.S., however, many aspects of HOV operations remain unknown.

Project 0-1353, *An Evaluation of High-Occupancy Vehicle Projects in Texas,* will conduct a comprehensive "before-and-after" evaluation of committed HOV projects in Houston and Dallas. In addition, the project will assess the air-quality impacts of HOV projects, monitor the status of all priority treatment projects in Texas, and will assist TxDOT (as needed) with both priority treatment and park-and-ride programs.

This study builds on the success of a previous study, the results of which have been used extensively throughout the U.S. and particularly in Texas (e.g., in El Paso, San Antonio, Austin, Fort Worth, Dallas, and Houston).

Among their many benefits, HOV projects can increase capacity on existing freeways and can reduce air pollution, energy consumption, and parking requirements at activity centers. Overall, correctly implemented HOV projects represent — for both highway and transit expenditures — a more cost-effective use of limited federal, state, and local tax dollars.

The major effort of this and all previous HOV research has been to assist TxDOT in HOV project implementation.

The researchers will need experimental sites in Dallas and Houston. The project runs from September 1993 through August 1998.

Area 1 — PD: Alvin R. Luedecke, Jr., P.E., TPP
Researcher: Dr. Dennis L. Christiansen, P.E., TTI

Fire Leads To Evaluation of Pavement Repair Materials

A 1991 chemical fire on I-45 — the result of an accident that occurred approximately 2 miles north of the Freestone County line near Corsicana — damaged a 660-foot concrete pavement section of the highway's southbound lanes. This pavement damage was in the form of mostly shallow spalls, which the Dallas District patched with asphalt.

Using this fire-damaged section, Project 7-1948, *Repair of Fire-Damaged Concrete on I-45,* is evaluating various concrete pavement repair materials under actual traffic conditions. The materials to be placed and evaluated include:

- User-formulated polymer concrete, which consists of dry aggregate placed in the spalled area and saturated with a low-viscosity monomer.
- Prepackaged polymer concrete, which comes in a two-component mixture (a liquid monomer and sand). Coarse aggregate may be added if spall depth exceeds 1 inch.
- Magnesium phosphate, a fast-setting repair material known as Set-45. The product comes packaged as a single-powdered component, which is activated by adding water. Again, coarse aggregate may be added for deeper spalls.
- Modified portland cement, a fast-setting cement marketed under the trade name "Pyrament." This is a portland cement mix having a very low water-cement ratio that exhibits excellent bonding and strength characteristics.
- Crack sealing monomer, a low-viscosity monomer that has proven very effective in sealing cracks less than 0.01 inch at the surface in concrete pavements.

With TxDOT providing traffic control and spall cleaning, CTR repaired the damaged section on July 14, 1993. The researchers, now monitoring the repaired areas, will summarize the performance of the repair materials in a report to be submitted this summer.

The project will document the various materials' performance under actual traffic conditions. The final report, to be made available to all TxDOT maintenance personnel, will summarize the materials used, mix design, repair methods, and evaluation results.

The project runs from June 1991 through August 1994.

Area 2 — PD: Darwin Meyers, P.E., DAL
Researchers: Drs. B. F. McCullough and David Fowler, CTR

Providing Reasonable Roads for Cyclists

Recent highway liability litigation has established that cyclists have a right to expect roadways to be reasonably free of hazards. To date, only limited research efforts have been made to determine what the limits of "reasonable" are, what safety requirements must be observed, and what roadway hazards exist for bicyclists.

Research study 0-1394, *Detection and Mitigation of Roadway Hazards for Bicyclists,* will study bicycle operation in various urban and rural parts of the state and will identify existing conditions and future requirements for improvement. Researchers will examine relevant current roadway design standards, operating characteristics, and traffic management practices. In addition, they will study maintenance and signing procedures presently employed and those planned for the future.

Traffic Operations Division will implement results as uniform, statewide guidelines for identifying, prioritizing, and removing roadway hazards for bicyclists.

The study runs from September 1993 and ends in August 1995.

Area 3 — PD: Paul Douglas, P.E., TRF
Researchers: Dr. Hani S. Mahmassani, P.E., CTR, S. Ardekani and S. Govind, UTA

Focus on Research

The purpose of ***Focus on Research*** *is to update engineers and technicians on items of interest in active upcoming projects. The contents of the various articles do not necessarily reflect the official views of the FHWA or TxDOT.*

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